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Anaesthetic considerations for paediatric ambulatory surgery

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Abstract

Successful anaesthetic management of children undergoing ambulatory surgery requires that the anaesthesiologist be actively involved in all aspects of management. Guidelines should be established in consultation with the surgeons, nurses, and administrators to ensure proper selection and preoperative preparation of patients. The psychological evaluation and preparation of the child, and the use of pharmacologic premedication when indicated, will ensure a pleasant experience for all involved. The anaesthesiologist should choose a specific anaesthetic agent and a technique that is appropriate for each individual child. Early ambulation and discharge are very desirable in ambulatory patients. Long-acting drugs and techniques that are associated with excessive drowsiness or nausea and vomiting should not be used. Special attention must be paid to the analgesic requirements of the child. Regional blocks should be used whenever possible to supplement general anaesthesia and to limit the need for narcotics during recovery. Postoperative vomiting should be anticipated and managed appropriately. Specific criteria for discharge ensure the safety and protection of the child and staff. © 1997 Elsevier Science B.V.

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1. Introduction

Children are excellent candidates for ambulatory (out-patient or day) surgery. The typical paediatric surgical patient is generally healthy and has no serious systemic disorders. Furthermore, most surgical procedures in children are simple and require less complicated techniques than those used in adults. Paediatric ambulatory patients also benefit from the minimization of parental separation and the reduction of exposure to hospital-acquired infections.

2. Patient selection criteria

A successful ambulatory surgery program requires that well-defined patient selection criteria be established and strictly adhered to by all surgeons who have admitting privileges in the facility. The three primary factors that must be considered when selecting a child for ambulatory surgery are the condition of the patient; the attitude of the parents; and the type of surgical procedure to be performed. These factors must be balanced with the capability of the surgical facility and the ability of its staff to deal with any expected or unexpected complications.

2.1. The patient

The child should be in good health; if not, any systemic disease must be under good control. Some anaesthesiologists and surgeons still restrict ambulatory

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surgery to patients classified as ASA physical status 1 and 2, while others accept ASA physical status 3 or even 4 patients, provided that their medical condition is well controlled.

Many children with chronic diseases are appropriate candidates for ambulatory surgery as long as their diseases are under control. Physically handicapped, psychologically disturbed, or mentally retarded children are especially comforted by continued presence of a parent or guardian that is usually fostered in ambulatory surgical facilities.

The premature infant, however, is not a suitable candidate for ambulatory surgery because of potential immaturity of respiratory center, temperature control, and gag reflexes. Recent studies have reported a high incidence of perioperative complications such as apnea in these infants.

The age at which the premature infant attains physiologic maturity and no longer presents an increased risk for postoperative apnea must be considered individually. Criteria on which these decisions are based include growth and development, persistent problems during feeding, time to recovery from upper respiratory infections, history of apnea, and presence or absence of anaemia, metabolic, endocrine, neurologic, or cardiac disorders.

It is generally considered that infants younger than 46 weeks' postconceptual age (PCA, which is the sum of gestational and post-natal ages) and/or preoperative history of apnea or anaemia are at greatest risk, although some authors have reported apnea in infants as old as 60 weeks' PCA. Children with lower gestational age are more susceptible to apnea. As the child matures, the tendency toward apnea greatly diminishes; however, the age when all infants may be safely anesthetized on an ambulatory basis is unknown. Until more extensive, prospective studies are carried out, it seems prudent to have a high index of suspicion. Many anaesthesiologists admit to the hospital all ex-premature infants who are younger than 50 weeks' post-conceptual age so that they may be monitored postoperatively for apnea, bradycardia, and oxygen desaturation. The choice of this particular age is rather arbitrary. It is best to individualize this decision and, when in doubt, to err on the conservative side. If the infant has bronchopulmonary dysplasia (BPD), anaemia or other neonatal problems, this period may need to be extended. Should any questions arise, in-patient care and postoperative monitoring are recommended. Infants with apnea in the recovery room should also be admitted and monitored [1].

2.2. The child with a runny nose

A child who presents with a runny nose may have a completely benign, non-infectious condition (e.g. seasonal or vasomotor rhinitis), in which case elective surgery may safely be performed. On the other hand, the runny nose may be a prodrome to, or actually be, an infectious process, in which case elective surgery may need to be postponed. Since an estimated 20–30% of all children have a runny nose a significant part of the year, every child with a runny nose must be evaluated on an individual basis.

The pre-anaesthetic assessment of these patients consists of a complete history, a physical examination, and an interpretation of certain laboratory data. Early in the clinical course of disease, the history will be the most important factor in the differential diagnosis. Specifically, allergic problems should be actively sought. Parents can usually tell whether their child's runny nose is 'the usual runny nose' or something different that may require cancellation of elective surgery. The physical examination is not always conclusive; normal findings may be present during the early part of an infectious process. Chronic allergic rhinitis, on the other hand, may be associated with local infections within the nasopharynx resulting in purulent nasal discharge. A white blood cell count $\geq 12\,000$–$15\,000$ with a shift to the left suggests an infectious process.

If surgery is postponed because of simple nasopharyngitis, it can be usually scheduled in 1–2 weeks. If a flu-like syndrome that involves both upper and lower respiratory tract is present, surgery should be postponed until at least a month after the child has recovered.

2.3. The parent

Parents of paediatric ambulatory patients should be capable of understanding and willing to follow specific instructions related to ambulatory surgery. In most cases, it is up to the physician to educate them and make them feel secure and comfortable.

2.4. The procedure

The planned surgical procedure should be associated with only minimal bleeding and minor physiologic derangements. Superficial procedures are selected most often. The length of the procedure is not in itself a significant drawback. Most experts believe that almost any operation that does not require a major intervention into the cranial vault, abdomen, or thorax can be performed on an ambulatory basis. Patients with infected lesions are not good candidates because of the need for separate facilities in the recovery area.

The five most frequently performed ambulatory surgical procedures at the Children's National Medical Center (CNMC) during the past 2 years were herniorrhaphy, myringotomy, adenoidectomy with or without

myringotomy, circumcision, and eye-muscle surgery. Recent experience indicates that ambulatory adenotonsillectomy is also safe and cost-effective and that there is little benefit in keeping these patients in the hospital more than a few hours after surgery. Young children (< 3 years) who are undergoing tonsillectomy for the relief of severe airway obstruction, with or without sleep apnea, continue to suffer from the same symptoms in the immediate postoperative period and should, therefore, be admitted to the hospital for close observation and monitoring postoperatively.

3. Preoperative requirements and screening

The preoperative requirements for safe conduct of anaesthesia in paediatric ambulatory patients are the same as those for in-patients, including a complete history and physical examination, indicated laboratory tests based on the findings from history and physical examination, consultations when indicated, and an appropriate fasting period. In order to minimize delays and cancellations, it is desirable to complete as many of these requirements as possible before the day of surgery.

Many ambulatory surgical units actively participate in the preoperative screening of their patients. The degree of involvement varies from a simple telephone call to the parents a day or two prior to surgery to the establishment of a formal screening clinic to clear all patients before admission into the operating suite. Many anesthesiologists function as the medical directors of their facilities, and perform the role of the perioperative physician. At CNMC, the parents of each child are contacted by telephone shortly after the operation is scheduled. A second call is made 48 h or less before surgery. During the initial call, information is sought concerning past or present risk factors, such as a history of prematurity or cardiac or respiratory problems. This information helps to determine if additional preoperative evaluation or consultation is required prior to the day of surgery. In some cases, it may lead to a re-evaluation of the appropriateness of scheduling the procedure on an ambulatory basis. During the second phone call, an assessment of the child's present health is made. Fasting (NPO) orders are reinforced, and practical matters related to parking, what to bring to the hospital, and expected duration of stay are explained.

On the day of surgery, all patients are screened for acute illness and NPO status. Vital signs are recorded. Any consultation reports are evaluated, and the need for special preoperative psychological or pharmacologic treatment is considered before the child arrives into the operating room area.

4. Preoperative preparation

The time between the patient's arrival at the hospital and the induction of anaesthesia is usually quite short. There is little time to orient the child to all the events that will take place during his or her stay. Most centers, therefore, encourage children and families to participate in presurgical preparation programs a few days before surgery, and studies have shown that children who attended those programs were much more cooperative during induction than those who did not. Such findings, however, must be interpreted carefully, since parental motivation, travelling distance, socioeconomic conditions, and the child's age; the forces that motivate parents to bring their children to these programs, are the same factors that may in themselves lead to better cooperation.

5. Pharmacologic premedication

The value of and need for pharmacologic premedication in paediatric ambulatory patients is controversial. Although a majority of children do not need preoperative sedation, provided that they have received proper psychological preparation and established a good rapport with the anesthesiologist, some do. Midazolam 0.5 mg/kg can be administered orally 20–45 min before induction to facilitate separation from the parents and improve the child's cooperation during induction [2]. Alternatives to midazolam include oral ketamine (6 mg/kg) and Oral Transmucosal Fentanyl Citrate (5–10 μg/kg) [3]. When premedication is not used routinely, the anesthesiologist must be prepared to administer a preinduction agent to the occasional difficult or extremely frightened child.

6. Preinduction agents

Preinduction of anaesthesia refers to the use of such drugs as ketamine or other rapidly acting medications for last-minute sedation.

Rectal administration of methohexital is a commonly used technique in preschool children. A dose of 25 mg/kg (10% solution) has an onset time of 6–10 min and produces enough sedation to peacefully separate an upset child from his or her parents [4]. Rectal [5] or intranasal administration of midazolam (0.2 mg/kg) also has been reported to produce anxiolysis and sedation in preschool children with a rapid onset (5–10 min) and no evidence of delayed recovery [6].

Low-dose (2 mg/kg) intramuscular ketamine can be used in young children who do not cooperate with other methods of induction [7]. The onset time is short (2–3 min), and recovery is not prolonged. When ke-

tamine is followed by an inhaled technique, there is minimal likelihood of delirium or bad dreams during recovery.

7. Anaesthetic agents and techniques

Smooth induction of anaesthesia in the unpremedicated child is probably the most difficult aspect of paediatric ambulatory surgery. No single approach is effective for all children in all situations. The choice of a particular agent and technique must be based on the needs of the individual child; it should not be used merely because it is the routine choice in a particular institution or because it is the only method with which the anaesthesiologist is comfortable.

7.1. Inhalational techniques

Inhalational induction is a popular choice in paediatric anaesthesia. Techniques that reduce the anxiety associated with inhalation induction, and therefore promote patient cooperation, include the use of transparent masks, painting the inside of the mask with a drop of food flavour of the child's choice, allowing the child to sit up, and encourage the parents to be present during the induction [8].

For the past 30 years halothane has been the most commonly used inhalational anaesthetic in paediatric patients. It is usually combined with nitrous oxide to provide rapid and smooth onset, as well as quick recovery following operations lasting 1 h or less. Nausea and vomiting are not common. With prolonged administration of halothane, recovery time is longer than when isoflurane is used.

Although considered by many to be the standard inhalational agent in adult anaesthesia practice, isoflurane is not commonly used as an induction agent in paediatric ambulatory patients. It has a pungent odour which makes inhalational induction more difficult and associated with more airway irritation than halothane. The slightly lower blood solubility, compared to halothane, does not result in any clinically significant difference in the speed of recovery when either agent is used for the usually short (< 1 h) procedures typically performed in ambulatory patients. Isoflurane is more compatible with catecholamines than halothane, and is frequently used if these agents must be infiltrated by the surgeon to improve haemostasis.

Enflurane has very similar physical characteristics to isoflurane, however, because of its pungency, it is not a very popular agent in paediatric ambulatory patients.

Desflurane has chemical and physical characteristics that are extremely attractive for surgical ambulatory patients. The low solubility, close to that of nitrous oxide, should allow for very fast induction and recovery, as well as ease of controlling the anesthetic depth. Desflurane is not indicated for start of anaesthesia induction in children because it results in a high incidence of airway irritation, coughing and laryngospasm that results in desaturation severe enough to require emergent use of succinylcholine in many patients. Desflurane, however, can be easily introduced following other induction agents, typically halothane or sevoflurane. This results in significantly faster emergence and recovery than when halothane is used [9]. Recovery following unsupplemented desflurane anaesthesia can be associated with a very high incidence of agitation and dysphoria. This can be modified or prevented by the judicious use of opioids, midazolam or propofol. Although these treatments do not usually delay emergence from anaesthesia, they often prolong discharge home time.

Sevoflurane has solubility characteristics closer to those of desflurane than to isoflurane. The drug has a very pleasant smell which makes it the least irritating inhalational induction agent available [10]. Sevoflurane can, therefore, be used for both induction and maintenance of anaesthesia in children. Clinical experience with sevoflurane so far has been extensive in Japan. Sevoflurane results in smooth induction with no airway irritation, and significantly faster emergence and recovery when compared to halothane [11]. Since its introduction in the United States last year, it has quickly become the inhalational induction agent of choice for children.

7.2. Intravenous techniques

Intravenous induction is the method of choice in most older children. It is expected that the availability of the eutectic mixture of the two local anaesthetics lidocaine and prilocaine (EMLA), which can be used to perform painless venipuncture in children, will encourage more anaesthesiologists to offer, and more children to accept an intravenous induction. The use of EMLA in Europe and Canada has already increased the acceptance of i.v. induction in children. The use of EMLA in ambulatory patients requires careful planning, since at least 1 h of contact time under an occlusive dressing is required for full effect. In most cases EMLA should be applied to two potential i.v. sites to have a back-up site available in case the first venipuncture is not successful.

When thiopental sodium is used in healthy unpremedicated children, a relatively large dose (5–6 mg/kg) may be required in order to ensure smooth and rapid transition to general inhalational anaesthesia. Children who receive barbiturate induction tend to be sleepier and require more airway support for the first

15 min of the recovery period than those who have received halothane. This difference disappears by 30 min.

Recent studies on the use of propofol in children indicate that it results in smooth induction with a lower incidence of side effects and faster recovery than thiopental. Propofol can be used in a dose of 2.5–3.5 mg/kg for induction of anaesthesia in children who accept venipuncture [12]. Pain on injection can be minimized or even prevented by using the large antecubital veins for the drug administration. If the hand veins must be used, lidocaine can be mixed with propofol (1–2 mg lidocaine/1 ml of propofol) immediately prior to its injection, with excellent results. When propofol induction is followed by halothane maintenance, recovery is significantly faster than when thiopental induction is followed by halothane. Recovery is fastest if propofol induction is followed by a propofol infusion for the maintenance of anaesthesia. Because of their higher volume of distribution and increased clearance, children require a higher infusion rate (125–300 μg/kg/min) than adults. This is especially true for younger children, and during the early part of maintenance.

Propofol anaesthesia has been consistently shown to be associated with an extremely low incidence of postoperative vomiting even following surgical procedures that normally result in vomiting e.g. strabismus surgery [13].

7.3. Anti-emetics

Routine use of anti-emetic prophylaxis is not indicated in all paediatric patients. For children undergoing procedures known to be associated with a very high incidence of postoperative vomiting, e.g. eye-muscle surgery, the use of propofol has been shown to be very effective in preventing this complication. Although some of the traditional anti-emetic drugs are at least partially effective, their use is associated with significant side-effects such as prolonged recovery and extrapyramidal symptoms (droperidol 50–75 μg/kg), or gastrointestinal disturbances (metoclopramide 0.15 mg/kg). More recently, ondansetron has been reported to reduce vomiting in children following such vomiting-prone procedures as tonsillectomy, where more conventional anti-emetics have little or no effect [14].

For patients with persistent postoperative vomiting, our current approach is to stop any attempt at offering oral fluids and ensure adequate intravenous hydration. Intravenous metoclopramide is administered in a dose of 0.15–0.2 mg/kg. Occasionally rectal promethazine 0.5 mg/kg (Phenergan® 12.5–25 mg), or prochlorperazine 0.1 mg/kg (Compazine® 2.5–5 mg) are administered in the hospital and/or given to the parents to use at home.

8. Perioperative fluid management

8.1. Preoperative fasting

The need for prolonged period of fasting (e.g. NPO after midnight) before anaesthesia induction in otherwise healthy children has been recently questioned [15]. Several studies have shown that ingestion of clear liquids up to 2–3 h prior to scheduled induction does not increase the risk for pulmonary aspiration syndrome; consequently, some anaesthesiologists have altered fasting guidelines to allow clear liquids 2–3 h prior to surgery. It is important to note that these guidelines apply to clear liquids only (not solids) in otherwise healthy children. Possible benefits of shorter fasting times include minimizing thirst and discomfort while awaiting surgery, less hypovolemic-induced hypotension during induction and less concern about hypoglycemia.

The need for routine administration of intravenous fluids during paediatric ambulatory anaesthesia is controversial. If the procedure is of short duration and the anaesthetic technique is one that ensures rapid recovery and return of normal appetite with minimal nausea and vomiting, many believe that the patient does not require infusion of fluids. If fluids are not administered intravenously, the period of preoperative fasting should be minimized to avoid possible dehydration and hypoglycemia.

Intravenous fluid therapy during and after surgery is specifically indicated in longer operations (over 30–60 min); in procedures known to be associated with a high incidence of postoperative nausea and vomiting (e.g. strabismus surgery); and in young children who have been fasting for a prolonged period of time.

9. Postoperative analgesia

The need for analgesics following surgery depends upon the nature of the procedure and the pain threshold of the patient. It does not depend upon whether the child is an ambulatory or an in-patient. Postoperative pain or discomfort can be managed by one or a combination of the following methods.

9.1. Mild analgesics

For infants under 6 months of age, a combination of care and nursing (or a bottle) is all that is usually needed following a procedure that is not associated with severe pain.

For older infants and young children, acetaminophen (Tylenol®) can be used either orally or rectally in a dose of 60 mg (1 grain) per year of age.

For more persistent, moderately severe pain a Tylenol®/codeine combination is available in an elixir form containing 120 mg Tylenol® plus 12 mg codeine/5 ml. The recommended dose is 5 ml of the elixir for children 3–6 years of age, and 10 ml for those between the ages of 7 and 12.

9.2. Non-steroidal anti-inflammatory drugs (NSAID)

NSAIDs, e.g. ketorolac, have proved effective in relieving postoperative pain following minor operations in children. Early administration immediately following induction seems to provide optimal postoperative analgesia. More studies are required to determine the optimal dose and route of administration of ketorolac, as well as its efficacy as an analgesic following more painful ambulatory surgical procedures in children.

9.3. Potent narcotic analgesics

When narcotics are indicated in the recovery period, a short-acting drug should be chosen. Intravenous use allows more accurate titration of the dose and avoids the use of 'standard' dosages based on weight, which may lead to a relative overdose. Fentanyl, up to a dose of 2.0 μg/kg, is our drug of choice for intravenous use. Meperidine (0.5 mg/kg) and codeine (1.0–1.5 mg/kg) can be used intramuscularly if an intravenous route is not established.

9.4. Regional analgesia

Regional anaesthesia can be combined with light general anaesthesia to provide excellent postoperative pain relief and early ambulation, with minimal or no need for narcotics. By placing the block before surgery starts but after the child is asleep, one can reduce the requirement for general anesthetic agents during surgery, which in turn may result in a more rapid recovery, earlier discharge, more rapid return of normal appetite, and less nausea and vomiting.

The types of blocks that can be used safely in the paediatric ambulatory surgical patient are limited only by the skill and interest of the anesthesiologist. Generally, the techniques chosen should be simple to perform, have minimal or no side effects, and not interfere with motor function and early ambulation.

Ilioinguinal and iliohypogastric nerve block can be performed by infiltration of 0.25% bupivacaine solution (in doses up to 2 mg/kg) in the region medial to the anterior superior iliac spine. This block has been used successfully to provide excellent postoperative analgesia for paediatric ambulatory patients following elective inguinal herniotomy or orchiopexy.

Dorsal nerve block of the penis can be performed by simple injection of 1–4 ml of 0.25% bupivacaine without epinephrine deep to Buck's fascia 1 cm from the midline. This has been shown to provide over 6 h of analgesia following circumcision with no complications. Alternate approaches to penile block are a midline injection or subcutaneous infiltration, which presumably blocks the nerve after it has ramified into the subcutaneous tissue. Topical application of lidocaine on the incision site at the conclusion of surgery has also been shown to be effective.

Caudal block provides excellent and reproducible postoperative analgesia following a wide variety of surgical procedures such as circumcision, hypospadias repair, orchiopexy, and herniotomy. By using bupivacaine, 0.25% solution in a dose of 0.5–0.7 ml/kg, no motor paralysis is produced. Caudal block has been extensively used in our ambulatory surgical unit, with most children discharged home free of pain between 1 and 2 h postoperatively. Analgesia (as measured by subsequent need of a mild oral analgesic) lasts 4–6 h with this technique.

10. Discharge criteria

Rapid recovery and early ambulation are major objectives in ambulatory surgery. When dealing with paediatric ambulatory patients, we must guarantee safe discharge not only from the recovery room but also from the hospital. In our institution, all children recover from anaesthesia in the same recovery area. Ambulatory patients are then transferred to a special short-stay recovery unit.

In order to provide uniform care and to ensure a complete legal record, many institutions have developed specific discharge criteria for ambulatory patients. At CNMC, discharge criteria include the following: appropriateness and stability of vital signs; absence of respiratory distress; ability to swallow oral fluids, cough, or demonstrate a gag reflex; ability to ambulate consistent with the developmental age level; absence of excessive nausea, vomiting, and dizziness; and a state of consciousness appropriate to the developmental level. Recent studies suggest that children should not be required to drink before discharge from the hospital [16].

Every child, regardless of age, must have an escort home. The escort is given written instructions concerning the child's home care and a telephone number to call to request further advice or to report complications. Staff counsel all parents about postoperative care; many units have also designed handouts that specify the care that should be provided and the signs that might herald a complication.

11. Further reading

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